

10/650,645 filed 8/28/03

AMENDMENTS TO THE SPECIFICATION:

Please replace the second paragraph, lines 9 to 18, on page 8 with the following amended paragraph:

5 This invention contemplates the treatment of a fluid feedstock, e.g. various type organic materials, especially a fluid mixture of compounds of petroleum origin. In general, the fluid feedstock is a gaseous mixture comprising a more selectively permeable component and a less permeable component. Advantageously one or more of the module inlet streams may
10 comprises a mixture of liquid and condensable vapor. Optionally, the apparatus may further ~~comprise~~ ~~comprises~~ means for distribution of a "sweep" stream into the permeate chambers, but typically no sweep is required.

15 Please replace the paragraph at lines 12 to 25, on page 9 with the following amended paragraph:

20 This invention is particularly useful towards separations involving organic compounds, in particular compounds which are difficult to separate by conventional means such as fractional crystallization. Typically, these include organic compounds that are chemically related as for example a process for the separation and purification of para-xylene from mixed xylenes. Compared to current technologies for para-xylene purification, para-xylene is produced from the membrane process described herein at significantly reduced capital, operating, and energy costs. The
25 invention can also simultaneously meet para-xylene purity requirements and recover more para-xylene than conventional para-xylene purification processes. Having similar boiling points, simple distillation is a cost prohibitive method of purifying para-xylene from C8 aromatics.

10/650,645 filed 8/28/03

Please replace the paragraph at page 9, line 31 to line 4, on page 10 with the following amended paragraph:

5 The invention is hereinafter described in detail with reference to the accompanying drawing which is a schematic flow diagram depicting aspects of the membrane separation processes and apparatus of the present invention for simultaneous recover of a very pure permeate products ~~product~~ and one or more desired non-permeate product. The drawing depicts an embodiment of the present invention in which a plurality of membrane separation
10 devices is used to modify the composition of a mixture of chemical compounds.

Please replace the paragraph at lines 5 to 26, on page 12 with the following amended paragraph:

15 Concentration polarization is well controlled in bore-side feed modules. The feed solution passes directly across the active surface of the membrane, and no stagnant dead spaces are produced. This is far from the case in shell-side feed modules in which flow channeling and stagnant areas between fibers, which cause significant concentration polarization problems, are difficult
20 to avoid. Any suspended particulate matter in the feed solution is easily trapped in these stagnant areas, leading to irreversible fouling of the membrane. Baffles to direct the feed flow have been tried, but are not widely used. A more common method of minimizing concentration polarization is to direct the feed flow
25 normal to the direction of the hollow fibers. This produces a cross-flow module with relatively good flow distribution across the fiber surface. Several membrane modules may be connected in series, so high feed solution velocities can be used. A number of variants on this basic design have been described, for example U.S. Patent
30 Numbers 3,536,611 in the name of Phillip et al., 5,169,530 in the name of Sticker et al., 5,352,361 in the name of Prased ~~Prased~~ et al., and 5,470,469 in the name of Beckman which are incorporated

10/650,645 filed 8/28/03

herein by reference each in its entirety. The greatest single advantage of hollow-fiber modules is the ability to pack a very large membrane area into a single module.

5 Please replace the paragraph at page 12, line 28 to line 6, on page 13 with the following amended paragraph:

Para-xylene is produced or separated from petroleum and chemical feedstocks as a commodity chemical ultimately used in the production of polyester fiber and resin. When removed from most petroleum-derived feedstocks, para-xylene is found in mixtures
10 with other C8 aromatics; namely: meta-xylene (mX), ortho-xylene (oX), and ethylbenzene (EB). The three xylene isomers have an equilibrium ratio ratios of approximately 1:2:1 for PX:mX:oX, and depending on the source, ethylbenzene can comprise up to about 20 percent by weight of a C8 aromatics mixture leaving a balance
15 typically of from about 80 to about 99 percent by weight of xylene. Beneficially processes of this invention efficiently recovery purified para-xylene from the near equilibrium mixture, and submitting the remainder of the stream to an isomerization reactor to re-establish the equilibrium.

20 Please replace the paragraph at lines 7 to 22, on page 13 with the following amended paragraph:

Referring to the right side of the drawing, where a membrane device 20 is disposed according to a preferred aspect of the invention. Membrane device 20 comprises a perm-selective
25 membrane that under suitable differential of driving force exhibits a permeability of at least 0.01 Barrer, channels having at least one inlet and one outlet for flow of fluid in contact with one side of a membrane, and contiguous with the opposite side thereof a permeate chamber having at least one outlet for flow of permeate.
30 A mixture of two or more compounds which when subjected to appropriately altered conditions of temperature and/or pressure

10/650,645 filed 8/28/03

exhibit a bubble point is introduced through conduit 18. The enthalpy of the feed is adjusted by suitable means, for example of exchanger 10 such that the Membrane Efficiency Index of the nonpermeate fluid, withdrawn through conduit 22, is within a
5 range from about 0.5 to about 1.5. Permeate is withdrawn through conduit 24.

Please replace the paragraph at lines 11 to 26, on page 15 with the following amended paragraph:

10 In preferred embodiments of the present invention, pumps 34 and 64, heat exchangers 10, 40 and 70, and the enthalpy of mixtures to be separated, for example from ~~form~~ sources 12 and/or 112 are adjusted simultaneously so that the MEI of the nonpermeate product fluid from membrane module 20 is within a range from about 0.5 to about 1.5. In another embodiment of the
15 present invention, pump 64, heat exchanger 70, and/or the enthalpy of a fluid mixture from source 112 are adjusted so that the MEI of the nonpermeate fluid from membrane module 80 is within a range from about 0.5 to about 1.5. In yet another embodiment of the present invention, pump 34, heat exchanger 40,
20 and/or the enthalpy of a feed mixture are adjusted so that the MEI of the fluid in conduit 52 is within a range from about 0.5 to about 1.5; and heat exchanger 40 and/or the enthalpy of another feed mixture are adjusted so that the MEI of the nonpermeate fluid from membrane module 50 is within a range from about 0.5 to about
25 1.5.

Please replace the paragraph at lines 16 to 21, on page 17 with the following amended paragraph:

The results in Table I show ~~the~~ that as permeate recovery increased permeate purity decreased. At the same time, more
30 material passed through the membrane and membrane cooling increased as membrane area increased. As membrane cooling

10/650,645 filed 8/28/03

increased, it was necessary to further vaporize the feed in order to maintain a MEI of one.

Please replace the ABSTRACT OF THE INVENTION, on page 29 with the following amended paragraph:

- 5 Apparatus and processes are disclosed for economical separation of fluid mixtures utilizing perm-selective membranes. Broadly, apparatus of the invention comprises a plurality of membrane modules comprising a solid perm-selective membrane and ~~equipment~~
10 ~~means~~ for controlling enthalpy of selected fluids within the apparatus. Advantageously, the membrane modules are disposed in a first product group, a second product group, and at least one intermediate group. Apparatus of the invention is particularly useful for simultaneous recovery of a very pure permeate product, and/or a
15 desired non-permeate stream, from fluid mixtures of two or more compounds which when subjected to appropriately altered conditions of temperature and/or pressure exhibit a bubble point.